

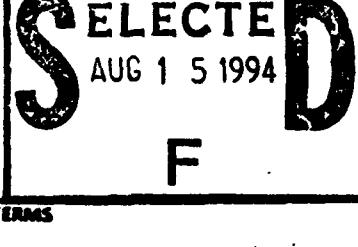
**AD-A282 926**

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REPORT DOCUMENTATION PAGE		Form Approved OMB No. 0704-0182
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1. AGENCY USE ONLY (Leave Blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED Quarterly (9/1/93-12/1/93)
4. TITLE AND SUBTITLE Representation & Recognition with Algebraic Invariants & Geometric Constraint Models		5. FUNDING NUMBERS DARPA Order No.: 8228
6. AUTHORS Dr. Joseph L. Mundy		Contract No.: MDA972-91-C-0053
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) GE - Corporate Research & Development P.O. Box 8 (K1, 5C39) Schenectady, NY 12301		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) DARPA/SISTO		10. SPONSORING/MONITORING AGENCY REPORT NUMBER <i>Q/P</i> 94-24515
11. SUPPLEMENTARY NOTES		
12. DISTRIBUTION/AVAILABILITY STATEMENT This document has been approved for public release and sale; its distribution is unlimited.		
13. ABSTRACT (Maximum 200 words) The theory of invariants of repeated structures has been validated experimentally. This class of object description appears very promising and extends the usefulness of invariants to a broad class of man-made objects.		
		
14. SUBJECT TERMS		15. NUMBER OF PAGES 7
		16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT
		20. LIMITATION OF ABSTRACT

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Sponsored by  
Advanced Research Projects Agency  
Software & Intelligent System Technology Office  
Representation and Recognition  
With Algebraic Invariants and  
Geometric Constraint Models  
ARPA Order NO. 8228  
Program Code No. N/A  
Contract No. MDA972-91-C-0053  
Sept. 1, 1993 - Dec. 1, 1993

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**Building KW, Room C248**  
**July 29, 1994**

**DARPA/SISTO**  
**Virginia Square Plaza**  
**3701 N. Fairfax Drive**  
**Arlington, VA 22203-1714**

**Attn.:** Dr. Oscar Firschein

**Subject:** Quarterly Reports

**Reference:** Contract #MDA972-91-C-0053 titled "Representation and Recognition with Algebraic Invariants and Geometric Constraint Models".

Please find enclosed one copy of the above-referenced report for the quarter ending December 1, 1993. It is provided to you per Section F-67 of the referenced contract. This report is approved for Public Release - Distribution Unlimited.

Please call if you have further questions.

Regards,

*Elizabeth J. Malloy*  
Elizabeth J. Malloy  
Contract Administrator  
Tel: (518) 387-7850, (FAX -7962)

Enclosures

**cc:**

1. Defense Technical Information Center  
Cameron Station, Attn.: DTIC-FDAC  
Alexandria, VA. 22304-6145 (two copies)
2. DARPA/SISTO  
Attn.: Edward R. Brown  
3701 North Fairfax Drive, 7th Floor  
Arlington, VA 22203-1714

## **Progress**

**Sept. 1, 1993 - Dec. 1, 1993**

Progress during this period is as follows:

- Initial experiments to test invariants for 3D repeated structures indicate that reliable affine structure can be recovered for translational symmetries.
- An algorithm for matching triples of parallel lines based on length ratio invariants has been evaluated and gives reliable results on Fort Hood test imagery.
- An occupancy measure, based on the statistics of edgel chains and chain junctions has been evaluated and gives reasonable qualitative results on various parking areas at the Fort Hood site.

## **Activities For Next Reporting Period**

The work planned for the next reporting period is as follows:

- Participate with AAI in the updating of the IUE specification.
- Upgrade the invariants recognition system in Target Jr with a new class hierarchy design.
- Evolve a new architecture for 3D object recognition based on model classes which support the computation of invariants from single 2D image views.

## **Equipment Purchased**

**None**

## **Changes in Key Personnel**

**None**

## **Summary of Information**

The theory of invariants of repeated structures has been validated experimentally. This class of object description appears very promising and extends the usefulness of invariants to a broad class of man-made objects.

## **Areas of Concern**

**None**

## **Related Accomplishments**

A second international workshop on invariants was held in Porto Delgada, Azores, co-sponsored by ARPA and ESPRIT, on October 9-14. Over 30 participants exchanged new results on the theory and implementation of invariant-related research.

Algebraic 11/93

REPORT DATE:  
November 1993 - FW348  
5340-8-9064

## COST AND MANHOUR TRACKING REPORT

## Representation &amp; Recognition with Algebraic Invariants

CONTRACT NO: MDA972-91-C-0053  
CONTRACTOR: GENERAL ELECTRIC CO  
CORPORATE RESEARCH & DEVELOPMENT

PRIOR YEARS  
1991 1992LAST MONTH  
YTD CURRENT  
MONTH MONTH CURRENT  
MONTH YTD TOTAL TO  
DATE

MATERIALS	0.4	70.6	<b>82.84</b>	4.2	<b>87.08</b>	158.110
DIRECT LABOR	60.3	154.8	74.1	0.0	74.1	289.184
PROJECT COST	145.8	434.4	<b>251</b>	4.3	<b>255.25</b>	835.480
EAC	9.2	21.3	13.8	0.2	14.0	44.511
B&P	0	0.0	23.8	0.4	24.2	24.249
COST OF MONEY						
D/L	7.1	13.7	6.3	0.0	6.3	27.076
P/C	0.1	0.1	0.0	0.0	0.0	0.200
<b>TOTAL</b>	<b>4.9</b>	<b>14.1</b>	<b>8.9</b>	<b>0.1</b>	<b>9.0</b>	<b>28.059</b>
TOTAL CONTRAC	167.0	483.7	303.8	5.0	308.9	959.575

## PROJECT COST

TASKS	MANHOURS			PROJECT COST		
	YTD/91/92	YTD/93	PRIOR YEARS TTD - P/C	1993 TTD - P/C	1993 TOTAL	1993 TOTAL
ALL	2820	1151.2	580.2	650.7	255.3	308.9
<b>TOTAL</b>	<b>3971.2</b>		<b>580.2</b>	<b>650.7</b>	<b>255.3</b>	<b>308.9</b>

P.S. The correct manhours for October is: 1151.2 . O hours for November.

O. Enwin 12/8/93

REPORT DATE  
October 1993- FW344  
5340-8-9064

## COST AND MANHOUR TRACKING REPORT

## Representation &amp; Recognition with Algebraic Invariants

CONTRACT NO: MDA972-91-C-0053  
CONTRACTOR: GENERAL ELECTRIC CO  
CORPORATE RESEARCH & DEVELOPMENT

	PRIOR YEARS 1991	PRIOR YEARS 1992	LAST MONTH YTD	CURRENT MONTH	CURRENT MONTH YTD	TOTAL TO DATE
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MATERIALS	0.4	70.6	81.69	1.2	82.84	153.870
DIRECT LABOR	60.3	154.8	72.9	1.2	74.1	289.179
PROJECT COST	145.8	434.4	247.22	3.8	251	831.230
EAC	9.2	21.3	13.6	0.2	13.8	44.277
B&P	0	0.0	23.5	0.4	23.8	23.845
 COST OF MONEY						
D/L	7.1	13.7	6.2	0.1	6.3	27.076
P/C	0.1	0.1	0.0	0.0	0.0	0.199
 FEE	4.9	14.1	8.7	0.1	8.9	27.911
 TOTAL CONTRAC	167.0	483.7	299.2	4.6	303.8	954.539

## MANHOURS

	TASKS	YTD/91/92	YTD/93	PRIOR YEARS TTD - P/C	PRIOR YEARS TOTAL	1993 TTD - P/C	1993 TOTAL	TOTAL
ALL	2820	1127.2		580.2	650.7	251.0	303.8	954.5
TOTAL		3647.2		580.2	650.7	251.0	303.8	954.5

Algebraic 9/93

REPORT DATE:  
September 1993- FW339  
5340-8-9064

## COST AND MANHOUR TRACKING REPORT

CONTRACT NO: MDA972-91-C-0053  
CONTRACTOR: GENERAL ELECTRIC CO  
CORPORATE RESEARCH & DEVELOPMENT

## Representation &amp; Recognition with Algebraic Invariants

	PRIOR YEARS		LAST MONTH YTD	CURRENT MONTH	CURRENT MONTH YTD	TOTAL TO DATE
	1991	1992				
MATERIALS	0.4	70.6		<b>81.62</b>	0.1	<b>81.69</b>
DIRECT LABOR	60.3	154.8	67.4	5.5	72.9	288.021
PROJECT COST	145.8	434.4	<b>234.6</b>	12.6	<b>247.22</b>	827.450
EAC	9.2	21.3	12.9	0.7	13.6	44.070
B&P	0	0.0	22.3	1.2	23.5	23.486
COST OF MONEY						
D/L	7.1	13.7	5.7	0.5	6.2	26.978
P/C	0.1	0.1	0.0	0.0	0.0	0.198
FE	4.9	14.1	8.3	0.5	8.8	27.777
TOTAL CONTRAC	167.0	483.7	283.8	15.4	299.3	949.959

## PROJECT COST

TASKS	MANHOURS			PRIOR YEARS TTD - P/C	PRIOR YEARS TTD - P/C	1993 TOTAL	1993 TOTAL	TOTAL
	YTD/91/92	YTD/93	YTD/93					
ALL	2820	1127.2		580.2	650.7	247.2	299.3	950.0
TOTAL		<b>3947.2</b>		580.2	650.7	247.2	299.3	950.0

O. Erwin

10/13/93

**GE Corporate Research & Development**  
**Representation & Recognition with Algebraic**  
**Invariants & Geometric Constraint Models**  
**DARPA Order No. 8228**  
**Contract No. MDA972-91-C-0053**

**R&D Status Report**  
**Program Financial Status**  
**Quarter Ending December 1, 1993**

	<u>CUMULATIVE TO DATE</u>	<u>AT COMPLETION</u>		
	Actual Expend.	% Compl.	BAC	LRE
<b>Subtotal</b>	<b>972,386</b>	<b>835,487</b>	<b>85.9</b>	<b>1,447,606</b>
<b>Management Reserve</b>				<b>1,447,606</b>
<b>Unallocated Resources</b>				
<b>TOTAL</b>	<b>972,386</b>	<b>835,487</b>	<b>85.9</b>	<b>1,447,606</b>